(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 026 718 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.08.2000 Bulletin 2000/32

(51) Int. Cl.[7]: **H01H 59/00**

(21) Application number: **99830731.8**

(22) Date of filing: **25.11.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **02.02.1999 IT TO990072**

(71) Applicant:
C.R.F. Societa' Consortile per Azioni
10043 Orbassano (Torino) (IT)

(72) Inventors:
- **Pizzi, Marco**
  10043 Orbassano, Torino (IT)
- **Koniachkine, Valerian**
  10043 Orbassano, Torino (IT)
- **Perlo, Piero**
  10043 Orbassano, Torino (IT)
- **Sinesi, Sabino**
  10043 Orbassano, Torino (IT)

(74) Representative:
Notaro, Giancarlo et al
c/o Buzzi, Notaro & Antonielli d'Oulx srl,
Corso Fiume 6
10133 Torino (IT)

(54) Electrostatically controlled micro-relay device

(57) An electrostatically controlled micro-relay device comprises a base (2) provided with a pair of separate electrodes (5, 6) and a petal (8) constituted by a conductive film having the ends connected to the base (2) and a movable part carrying a pair of movable contacts (10) adapted to co-operate with respective fixed contacts (11, 12) carried by the base (2). By applying an electric voltage between the petal (8) and one of electrode (5, 6) of the other, an adhesion is caused by electrostatically effect of one part of the petal to the base, which causes engagement of one or the other of the movable contacts (10) with the respective fixed contacts (11, 12).

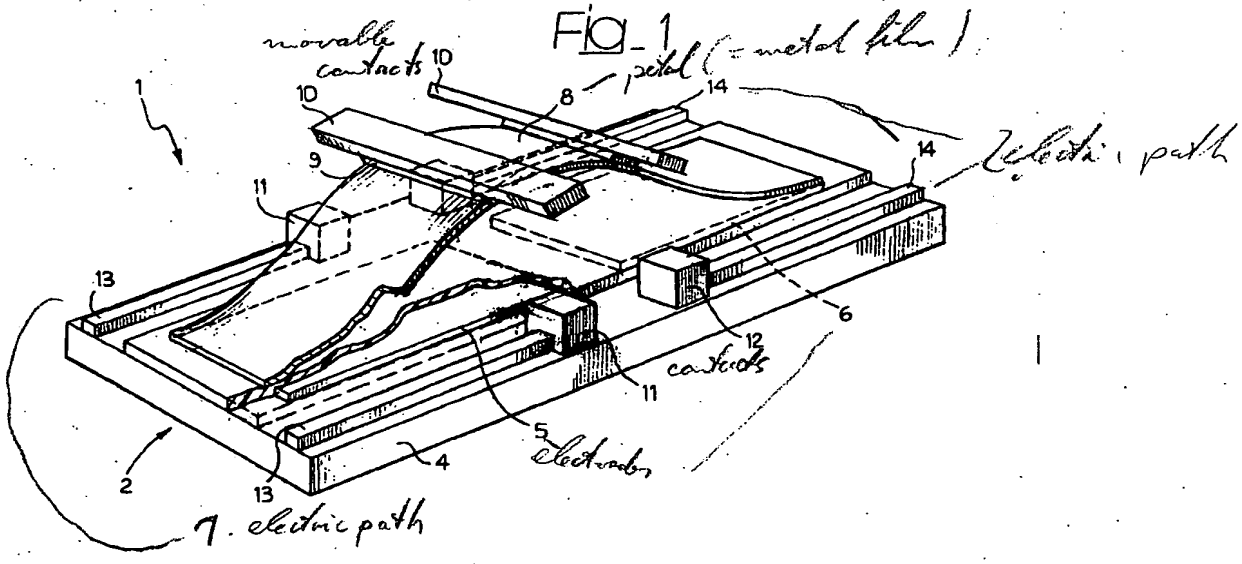

Fig. 1

EP 1 026 718 A2

Printed by Xerox (UK) Business Services
2.16.7 (HRS)/3.6

Description

[0001] The present invention relates to an electrostatically controlled micro-relay device.

[0002] There have been already proposed in the past electrostatic motors having low power and small dimensions suitable for use as actuators in micro-electronic technology applications, for actuating mechanical devices and the like in conditions in which vibrations take place, such as in the automotive field. These electrostatical actuators make use of flexible blades, also called cilia, or "petals", which are electrically conductive, each having one end associated with a stator and the opposite end adjacent to a movable element. The application of voltage pulses between the petals and one electrode associated to the movable element causes adhesion by electrostatical effect of the petals to the movable element with a resulting movement of the latter relative to the stator.

[0003] An actuator of the above indicated type is disclosed for example in Dyatlov V. L., Konyaskin V. V., Potapov B. S. and Pyankov Yu. A., "Prospects of the Employment of Synchrotron Radiation in film electrostatic actuator technology", Nuclear Instruments and Methods in Physics Research, A359 (1995), pages 394-395.

[0004] The object of the present invention is that of proposing a new improved type of micro-relay.

[0005] In view of achieving this object, the invention provides a micro-relay device characterised in that it comprises:

- a supporting base, carrying one electrode and one pair of fixed electric contacts, spaced apart from each other, located at the two sides of the electrode, and
- a movable petal, comprising a thin film of electrically conductive material, having at least a first end connected to the supporting base and a movable part carrying a movable contact which has end portions projecting laterally from the petal,
  said petal being adapted to be biassed by electrostatical effect towards said electrode when voltage is applied between said petal and said electrode, so that the end portions of said movable contact come into engagement with said pair of fixed electric contacts respectively.

[0006] In a preferred embodiment, the petal has both its ends connected to the supporting base and carries a second movable contact for co-operation with a second pair of fixed contacts provided on the supporting base at the two sides of a second electrode. In this preferred embodiment, one can alternatively cause closing either of the first movable contact on the first pair of fixed contacts or of the second movable contact on the second pair of fixed contacts, by alternatively applying voltage either between the petal and the first electrode or between the petal and the second electrode.

[0007] Further features and advantages of the invention will become apparent from the description which follows with reference to the annexed drawings, given purely by way of non limiting example, in which:

figure 1 is a diagrammatic perspective view of a preferred embodiment of the micro-relay according to the invention,
figures 2, 3, 4 are a lateral view, an end view and a plan view respectively of the micro-relay of figure 1,
figures 5, 6 also show a lateral view of the micro-relay of figure 1, but in two different operating conditions, and
figures 7, 8 also show end views of the micro-relay according to the invention in the two operative conditions of figures 5, 6.

[0008] In the drawings, numeral 1 generally designates a device comprising two electrostatic micro-relays. The device 1 comprises a supporting base or substrate 2, and a movable part 3. The supporting base 2 is constituted by a leaf 4 of alumina, silicon, glass, or plastic material, depending upon the applications, having a thickness of a few millimeters. On leaf 4 two separate electrodes 5, 6 are provided, such as by evaporation, sputtering, spin-coating or screen-printing. Subsequently the surface is insulated by a layer 7 of dielectric or ferroelectric material having a thickness between one tenth and a few tens of micrometers.

[0009] The movable part 3 is constituted by a petal 8 in form of a metal film, provided by evaporation or sputtering, having a thickness of a few micrometers and a length between a few hundreds of micrometers and a few millimeters. On the surface of film 8, at two separate areas in the central part thereof, two layers of insulating dielectric material 9 are provided having a thickness of a few micrometers. Above the layers 9, two bars 10 of electrically conductive material, acting as movable contacts are subsequently provided by evaporation or electrode deposition. The movable contacts 10 have a thickness of a few hundreds of micrometers, depending upon the electric current which is to be supplied through them. Petal 8 is secured at both its ends on the surface of base 2.

[0010] Above base 2, at the two sides of the dielectric layer 7, two pairs of fixed contacts 11, 12 are positioned respectively connected to two pairs of electric paths 13, 14 which are to be connected to an electric circuit.

[0011] As clearly visible in figures 5, 6, by applying an electric voltage between petal 8 and the first electrode 5 or between petal 8 and the second electrode 6, an adhesion is caused by electrostatical effect of one side or the other of petal 8 above base 2. Accordingly, an engagement of one of the two movable contacts 10 is determined with the co-operating pair of the fixed contacts 11 or 12, so as to close the circuit of the two elec-

tric path 13 or the two electric paths 14. When the supply of an electric voltage between the petal and one of the two electrodes 5, 6 is interrupted, petal 8 returns to the position shown in figures 1, 2 due to its elasticity.

[0012] Naturally, while the principle of the invention remains the same, the details of construction and the embodiments may widely vary with respect to what has been described and shown purely by way of example.

[0013] In particular, it is apparent that the invention may be applied also to the case in which one petal 8 is provided having a single movable contact 10 and cooperating with a single electrode 5, associated with a single pair of movable contacts 11. It is further apparent that petal 8 may have any shape and be connected to the fixed part of the device even only at one end thereof.

Claims

1. Electrostatically controlled micro-relay device comprising:

   - a supporting base (2), carrying at least one electrode (5) and a pair of fixed electric contacts (11) spaced apart from each other, located at the two sides of the electrode (5),
   - a movable petal (8) comprising a thin film of electrically conductive material, having at least one end portion connected to the supporting base (2) and a movable part carrying a movable contact (10) having an end portions projecting laterally from the petal (8),

   said petal being adapted to be biassed by electrostatical effect towards said electrode when an electric voltage is applied between the electrode (5) and the petal (8), so that said end portions of the movable contact (10) come into engagement with said pair of fixed contacts (11).

2. Micro-relay device according to claim 1, characterised in that the petal (8) has both its ends connected to the supporting base (2) and is provided with a second movable contact (10) which is for cooperation with a second pair of fixed contacts (10) provided above the supporting base (2) at the two sides of a second electrode (6) which is also associated to the supporting base (2) at a position spaced from said first electrode (5).

3. Micro-relay device according to claim 2, characterised in that the supporting base (2) includes a layer of dielectric material (7) which covers the first and second electrode (5, 6).

4. Micro-relay device according to claim 1, characterised in that the supporting base (2) includes a leaf (4) constituted by a material chosen among alumina, silicon, glass, plastics.

5. Micro-relay device according to claim 1, characterised in that the two said electrodes (5, 6) are made by a technique (10) chosen among evaporation, sputtering, screen-printing, spin coating.

6. Micro-relay device according to claim 2, characterised in that each movable contact (10) is arranged above the petal (8) with the interposition of a layer of dielectric material (9).

7. Micro-relay device according to claim 1, characterised in that also the movement of the petal away from said electrode (5) is obtained by applying an electric voltage.

FIG. 1

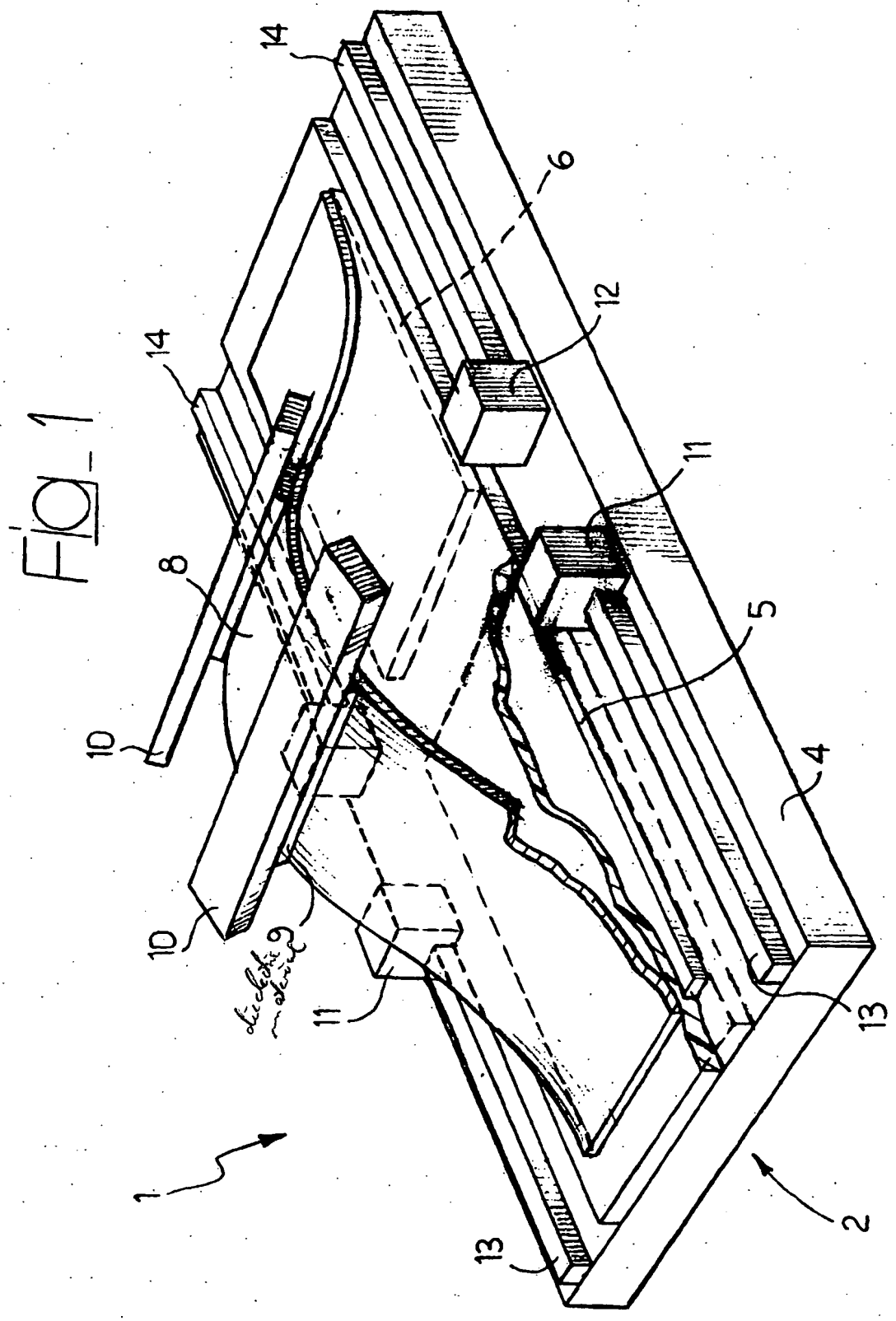

Fig_3

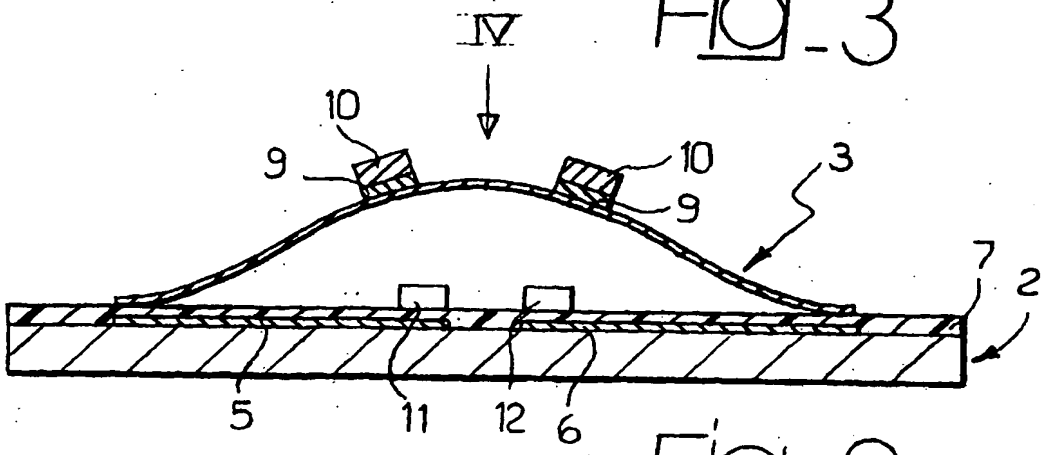

Fig_2

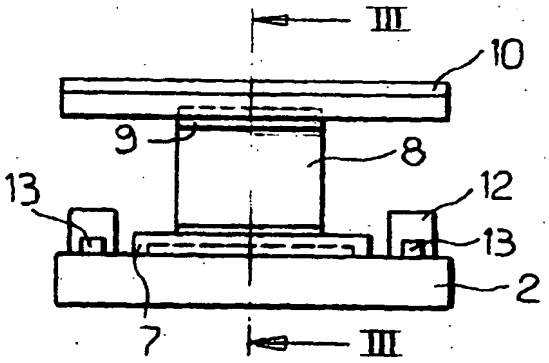

Fig_4

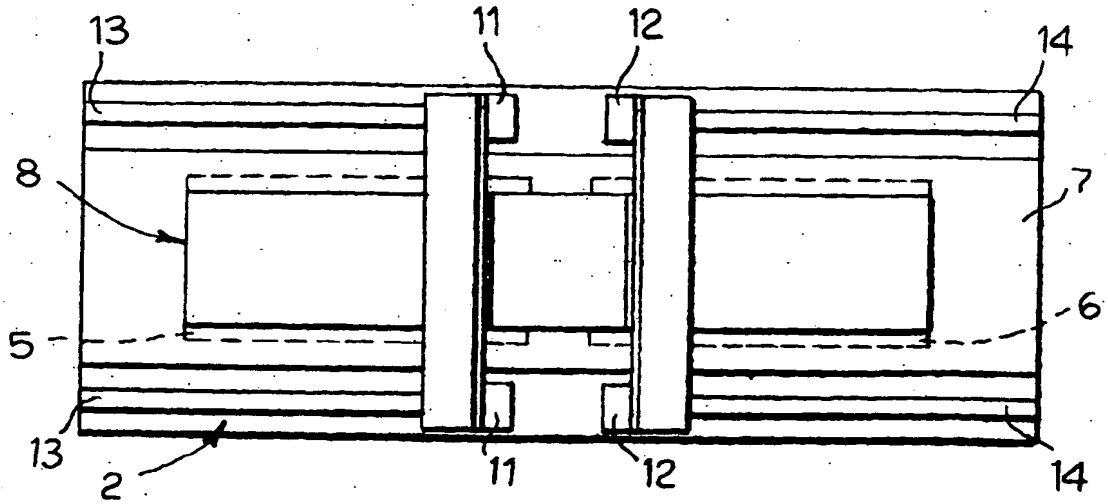

Fig_6

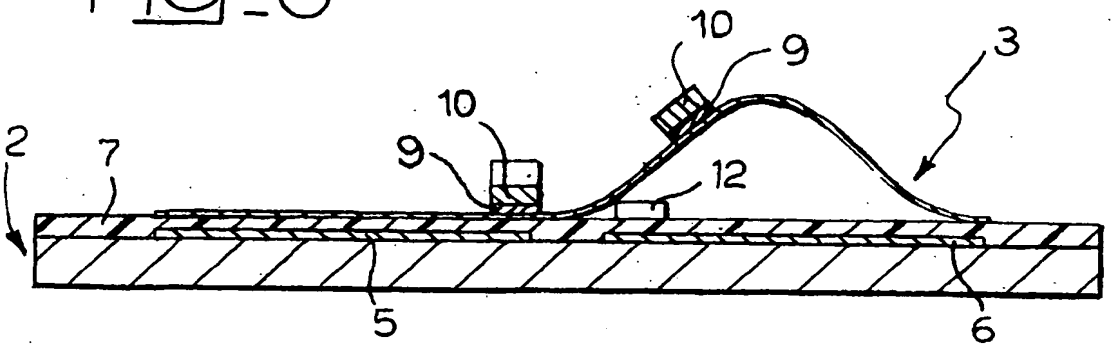

Fig_5

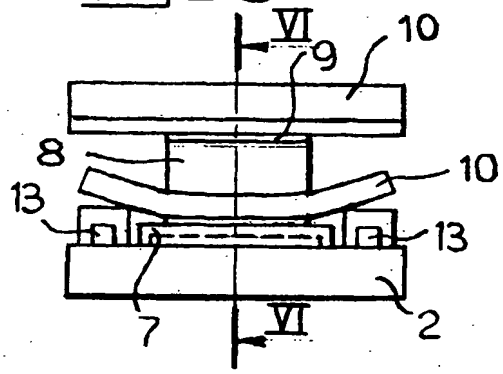

Fig_7

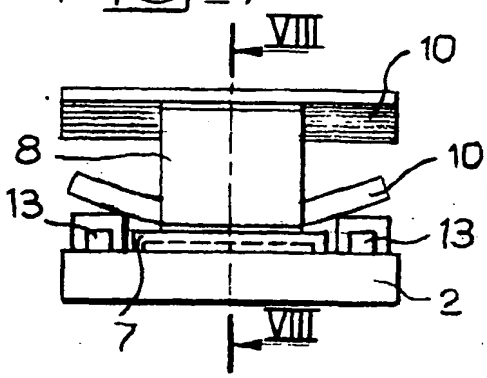

Fig_8